BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

ENVIRONMENTAL PROTECTION DIVISION
ENVIRONMENTAL SUSTAINABILITY DIVISION
MINISTRY OF ENVIRONMENT

Water Quality Assessment and Objectives for Windermere Lake

OVERVIEW REPORT

FIRST UPDATE

November 2010

Prepared by:

Alison Neufeld
Environmental Protection Division

Approved By: _____ _____

Lynn Kriwoken, Director
Water Protection & Sustainability
Environmental Sustainability Division

Date

Library and Archives Canada Cataloguing in Publication

Neufeld, Alison J., 1981-
Water quality assessment and objectives for Windermere Lake [electronic resource] : overview report / prepared by Alison Neufeld.

"First update".
"November 2010".
Electronic monograph in PDF format.
ISBN 978-0-7726-6362-7

1. Water quality--British Columbia--Windermere Lake. 2. Water quality--British Columbia--Kootenay Region. I. British Columbia. Environmental Protection and Assurance Division II. Title.

TD227 N6 N4 2010 363.739'420971162 C2010-909901-X

SUMMARY

This document is one in a series that presents water quality objectives for British Columbia. It has two parts: this overview and the technical report, which is available as a separate document. The overview provides general information about the water quality of Windermere Lake. It is intended for both technical readers and for readers who may not be familiar with the process of setting water quality objectives. Separate tables listing water quality objectives and monitoring recommendations are included. The technical report presents the details of the water quality assessment for Windermere Lake, and forms the basis of the recommendations and objectives presented here.

Water quality objectives were originally established in 1985 for Windermere Lake. These have been reviewed in this assessment and have been modified as appropriate to reflect the improved state of knowledge since 1985. Water quality objectives have been modified for turbidity and phosphorus, and new water quality objectives are recommended for temperature, total organic carbon, *E.coli* and dissolved oxygen.

Summary of existing and proposed water quality objectives for Windermere Lake (see Tables 1 and 2 for complete details).

Variable	Original Objectives (1985)		Revised Objectives (2010)	
	Site	Objective	Site	Objective
Turbidity	0200051 0200052 E262793	≤ 1 NTU (average) 5 NTU (maximum)	0200051 0200052 E262793	≤ 1 NTU (average) clear-flow period ≤ 5 NTU (maximum) clear-flow period 5 NTU (95th percentile) turbid-flow period
Phosphorus	0200051 0200052 E262793	≤ 0.010 mg/L (average)	0200051 0200052 E262793	10 µg/L (maximum)
Fecal coliforms	Bathing Beaches	≤ 200 MPN/100 mL (geo. mean) ≤ 400 MPN/100 mL (90th percentile)		
	Near Drinking Water Intakes	≤ 10 MPN/100 mL (90th percentile)		
Temperature			0200051 0200052 E262793	20 °C June (average) 25 °C July (average) 23 °C August (average)
E. coli			Bathing Beaches	≤ 77 CFU/100 mL (geo. mean)
			Drinking Water Intakes	≤ 10 CFU/100 mL (90th percentile)
TOC			Near Drinking Water Intakes	4 mg/L (maximum)
DO			0200051 0200052 E262793	≥ 5 mg/L (instantaneous minimum) ≥ 8 mg/L (average)

PREFACE

Purpose of Water Quality Objectives

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment's (MoE) mandate to manage water quality. Objectives are prepared only for those water bodies and water quality characteristics that may be affected by human activity now or in the future.

Authority to set Water Quality Objectives

The MoE has the authority to set water quality objectives under Section 5(e) of the *Environmental Management Act*.

How Objectives Are Determined

Water quality objectives are based on scientific water quality guidelines which are safe limits for the physical, chemical or biological characteristics of water, biota (plant and animal life) or sediment to protect the most sensitive designated water uses. A designated water use is one that is protected in a given location and is one of the following:

- Source water used for drinking water, public water supply and food processing;
- Aquatic life and wildlife;
- Agriculture (livestock watering and irrigation);
- Recreation and aesthetics;
- Industrial water supplies.

Objectives are established in British Columbia for water bodies on a site-specific basis taking into consideration local water quality, water uses, water movement, waste discharges and socio-economic factors. Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that water body.

How Objectives Are Used

Historically, water quality objectives have not been legally enforceable unless incorporated into an authorization for discharge such as a waste management permit. In 1999 the *Municipal Sewage Regulation* required that water quality objectives had to be met near municipal wastewater discharges. Objectives are most commonly used to guide the evaluation of water quality, the issuance of permits, licenses and legal orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular water body can be checked. Water quality objectives are also one means for assessing the ministry's performance in protecting water uses.

Objectives and Monitoring

Water quality objectives are established to protect all designated water uses that may take place in a given water body. Monitoring is undertaken to determine if the designated water uses are being protected. Monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at critical times, then they also will be protected when the threat to water quality is less. The monitoring usually takes place during a five-week period, twice during the calendar year which allows the specialists to measure the worst, as well as the average condition in the water. For some water bodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses and the way objectives are expressed (i.e. mean value, maximum value, 95^{th} percentile etc.).

INTRODUCTION

Windermere Lake (Figure 1) is located in the Rocky Mountain Trench in eastern British Columbia. The lake is actually a large widening in the Columbia River, just downstream from Columbia Lake, at the headwaters of the Columbia River. The village of Windermere is located on the east side of the lake, and the larger town of Invermere is located on the lake's northwestern corner.

Windermere Lake is a very popular vacation destination and has experienced considerable growth, including development of cottages, camping grounds, recreational beaches, golf courses and various tourist attractions. The Windermere Lake watershed is a multi-use watershed with high water demands for recreation, aquatic life, livestock watering and grazing, forest harvesting and source water for the public water supply (drinking water, livestock watering and irrigation). The predominant human use of water in this watershed is for recreation and domestic use.

The MoE originally developed water quality objectives for Windermere Lake in 1985 (Table 1; McKean and Nordin 1985). In this update, the water quality objectives from 1985 for Windermere Lake have been re-assessed using current information. The purpose of this report is to update the water quality objectives for this watershed to help ensure long-term sustainability of the water resource.

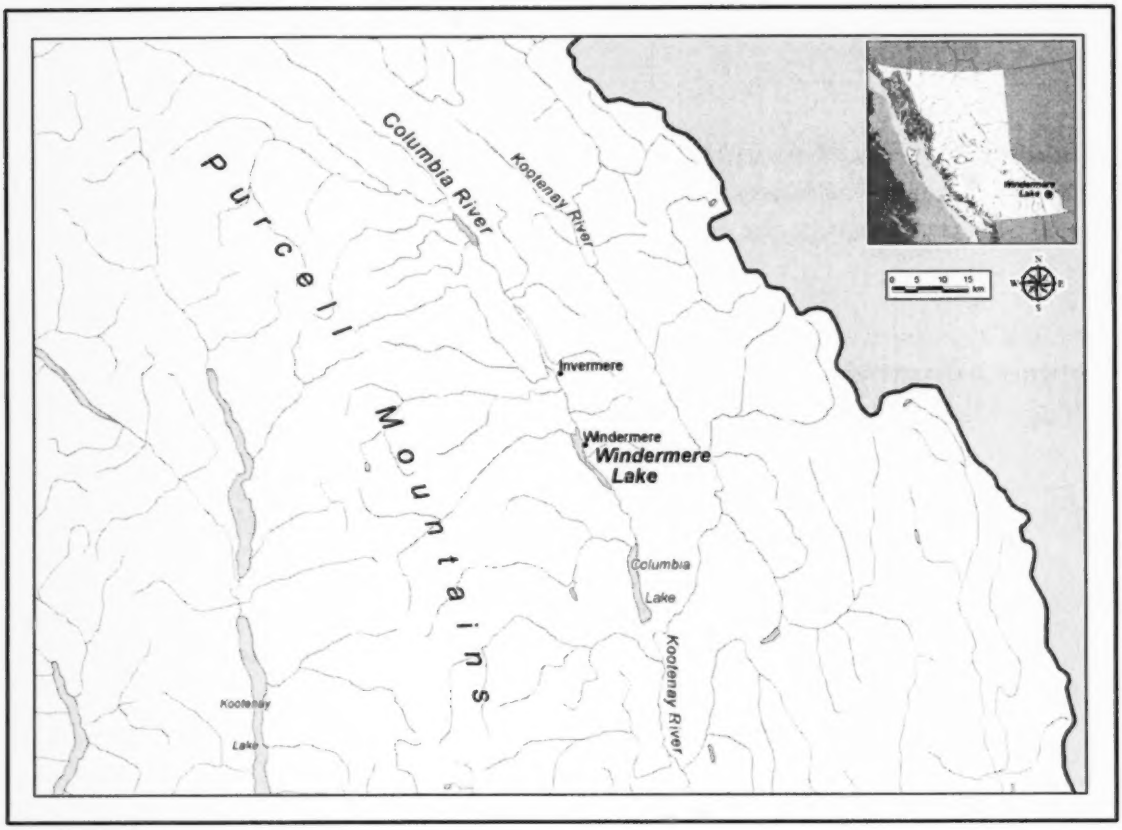

Figure 1. Location of Windermere Lake.

Table 1. Existing water quality objectives for Windermere Lake (McKean and Nordin 1985).

Designated water uses	Source waters used for drinking water, aquatic life, recreation, irrigation
Fecal coliforms (near water intakes)	≤ 10 MPN/100 mL (90th percentile)
Fecal coliforms (at bathing beaches)	≤ 200 MPN/100 mL (geometric mean) ≤ 400 MPN/100 mL (90th percentile)
Turbidity	≤ 1 NTU (average) 5 NTU (maximum)
Total phosphorus (under current conditions)	≤ 0.010 mg/L (average)
Total phosphorus (under Kootenay Diversion conditions)	≤ 0.011 mg/L (average)

BASIN PROFILE

Watershed and Hydrology

Windermere Lake is located in the eastern portion of British Columbia in the Rocky Mountain Trench at an elevation of 800 m (Figure 1). The surface area of the lake is 1,610 ha with approximately 1,530 ha of littoral area. The average depth of the lake is 3.4 m, with a maximum depth of 6.4 m. The perimeter of the lake is 36.3 km. McKean and Nordin (1985) estimated the average water retention time to be 0.13 years (47 days). The lake is oriented in the north-south direction and flows to the north. Windermere Lake and Columbia Lake (located to the south but upstream) are the headwaters for the Columbia River.

Windermere Lake has a snowmelt dominated hydrologic regime with peak flows occurring between early May and mid-August. The main tributary watersheds to Windermere Lake are the Columbia River, Windermere, Madias, and Holland creeks from the east, and Abel, Goldie, Brady, and Johnston creeks from the west. The largest flows into Windermere Lake originate from Columbia Lake. In the Columbia River, freshet occurs between May and September. In the tributaries, freshet occurs between June and August and low flows generally occur from October, through March.

Water Uses

Water withdrawn from Windermere Lake is used for domestic consumption, irrigation, and livestock watering. There are three community water systems that service the majority of residences around Windermere Lake. Several beaches exist on Windermere Lake and primary-contact recreation (swimming) is extensive during summer months. The majority of beaches are along the eastern shore of the lake and near Invermere at the northern end of the lake.

Windermere Lake is a part of the Columbia Wetlands. This wetland area has over 300 species of birds and mammals, and provides critical breeding grounds for bull trout,

kokanee salmon, rainbow trout and burbot. It is part of the Pacific flyway, providing refuge to 250 species of birds, including blue herons, bald eagles and osprey. It is also home to endangered species such as the painted turtle, red badger and short-eared owl. The wetlands at the north and south ends of Windermere Lake provide good to excellent sport and coarse fish habitat (Urban Systems 2001).

Land Uses

Residential development is concentrated along the north and east shores of Windermere Lake. The western side of the lake, which fronts the Purcell Mountains, has a railroad running along its shore and minimal housing and recreational development. There is an extensive flatland on the eastern side of the lake between the lake and the Rocky Mountains. This area has experienced considerable growth including development of cottages, campgrounds, recreational beaches, golf courses and various tourist attractions.

Within the Windermere Lake watershed, logging is confined to numerous small areas, with the most extensive logging occurring along Windermere Creek.

Agriculture in the area is not extensive. Cattle ranching is the main activity, with dairy farms and the production of vegetables and fruit making lesser contributions. Most of the cultivated land is used for hay and alfalfa production.

Water Quality Assessment and Objectives

Water Quality Assessment

The results of water samples collected between 2006 and 2009 show there has not been significant change in the water quality of Windermere Lake compared to historical data. Windermere Lake is shallow and well-mixed, with a water residence time of approximately 47 days. These factors combined with the amount of inflow received from the Columbia River allow Windermere Lake to effectively assimilate nutrients.

Phosphorus and nitrogen values at the three main lake stations are similar to, or have declined compared to historical data and neither of these parameters are a concern at this time. Turbidity values were highest in Windermere Creek, which may have been due to the impacts of forestry activity, or the gypsum mine within the watershed. Temperature values exceeded the water quality guideline during the summer months (June – September). Temperature and dissolved oxygen (DO) values indicate that the water column is well mixed. The pH of Windermere Lake appears to be slightly basic, consistent with historic values. This does not appear to be caused by human influence. Conductivity levels were typical of natural levels and remained fairly consistent over time. Sulphate levels were highest at the mid-lake station, resulting from inputs from Windermere Creek. Elevated concentrations of microbiological indicators were noted at both Athalmer and Invermere beaches. This is likely due to the beaches being located in embayments, the high recreational use of these areas and potential contributions from septic systems along the east shore of the lake.

Water quality results from the three main lake stations did not display much variation over the three year monitoring period. It is possible that impacts from non-point sources of pollution may be more evident in near-shore areas.

Water Quality Objectives

Water Quality Objectives have been re-assessed for key water quality parameters for Windermere Lake (Table 2). The objectives are based on recent ambient water quality data and the BC Approved and Working Water Quality Guidelines to protect water quality for designated uses. The proposed objectives are intended to protect the quality of water used for recreation, aquatic life and wildlife, irrigation and livestock watering, and source waters used for drinking. Water quality objectives have no legal standing and are not enforceable. The objectives may be considered as policy guidelines for resource managers to protect water uses in the specified water body. They will guide the evaluation of water quality, the issuing of permits, licences, and orders, and the management of fisheries and the Province's land base. They will also provide reference against which the state of water quality in a particular waterbody can be checked, and serve to make decisions on whether to initiate basin-wide water quality studies.

Depending on the circumstances, a waterbody may already meet the water quality objectives, or the objectives may act as a goal post of conditions to be met in the future. To limit the scope of work, water quality objectives are only prepared for waterbodies and water quality characteristics which may be affected by human activity now and in the foreseeable future.

Objectives for the following parameters have been added or modified since the 1985 assessment: phosphorus, microbiological indicators, turbidity, total organic carbon, temperature and dissolved oxygen. These new or modified water quality objectives will help prevent the impairment of water quality from non-point sources of contaminants.

Monitoring Recommendations

The recommended minimum monitoring for Windermere Lake is summarized in Table 3. Recommended sampling locations are shown in Figure 2. This program will determine if water quality objectives are being achieved, and will also aid in identifying shifts in trends over time for parameters where objectives have not been established (i.e., sulphate, conductivity, pH, nitrate, nitrite and total nitrogen). The program is based on technical

considerations; however, available resources could result in the program being either expanded or limited.

Alison Neufeld
Environmental Impact Assessment Biologist
Environmental Quality Section
Environmental Protection & Assurance Division
Ministry of Environment

Table 2: Proposed Water Quality Objectives for Windermere Lake

Parameter	Site	Objective
Turbidity[1]	0200051, 0200052, E262793	≤5 NTU (maximum)
		≤1 NTU (average)
	0200051, 0200052, E262793	5 NTU (95th percentile)
Temperature[2]	0200051, 0200052, E262793	20 °C June (average)
		25 °C July (average)
		23 °C August (average)
E. coli[3]	Bathing Beaches; Drinking Water Intakes	≤77 CFU/100 mL (geo. mean)
		≤10 CFU/100 mL (90th percentile)
Phosphorus[4]	0200051, 0200052, E262793	10 ug/L (maximum)
TOC[5]	Near Drinking Water Intakes	4 mg/L (maximum)
DO	0200051, 0200052, E262793	≥5 mg/L (instantaneous minimum)
		≥8 mg/L (average)

1. During the clear-flow period (August 16 through April 30) maximum turbidity at any time should be ≤5 NTU and mean turbidity (based on a minimum of five weekly samples collected within a 30-day period) during the clear-flow (non-freshet) period should be ≤ 1 NTU. During the turbid-flow period (May 1 through Aug 15), the 95th percentile turbidity should not exceed 5 NTU (based on a minimum of five weekly samples collected in a 30-day period).
2. For the protection of aquatic life, the average water temperature (measured in the top and bottom of the water column) should not exceed 20 °C, 25 °C, and 23 °C, in June, July, and August, respectively.
3. To protect primary-contact recreation, the geometric mean for *E. coli* should be ≤ 77 CFU/100 mL. To protect drinking water sources, the 90th percentile *E. coli* count should be ≤ 10 CFU/100 mL near drinking water intakes. These statistics are to be calculated from at least five weekly samples collected within a 30-day period.
4. Monitoring to check for attainment of the objective should take place as soon as possible after ice-off to determine if any internal P loading is occurring over winter.
5. To protect drinking water quality total organic carbon (near water intakes) should not exceed a maximum of 4 mg/L at any time.

Table 3: Recommended monitoring program for checking attainment of water quality objectives for Windermere Lake.

Parameter	Site	Depth	Frequency and Timing
Turbidity, temperature, conductivity, pH, DO	0200051, 0200052, E262793		Five times (weekly) in 30 days during the turbid-flow period (May 1 – August 15). Five times (weekly) in 30 days during the clear-flow period (August 16 – April 30).
E. coli	Bathing beaches (Athalmer, Invermere and Windermere beaches minimum)		Weekly June 15 – August 31
	Water intakes		Weekly June 15 – August 31
Total and dissolved phosphorus	0200051, 0200052, E262793	Surface and 1 m above the bottom	Monthly (June – August)
TOC	Near water intakes		Monthly (June – August)
Dissolved sulphate	0200051	Surface and 1 m above the bottom	Monthly (June – August)
Total nitrogen, nitrite, nitrate, chloride	0200051, 0200052, E262793	Surface and 1 m above the bottom	Monthly (June – August)

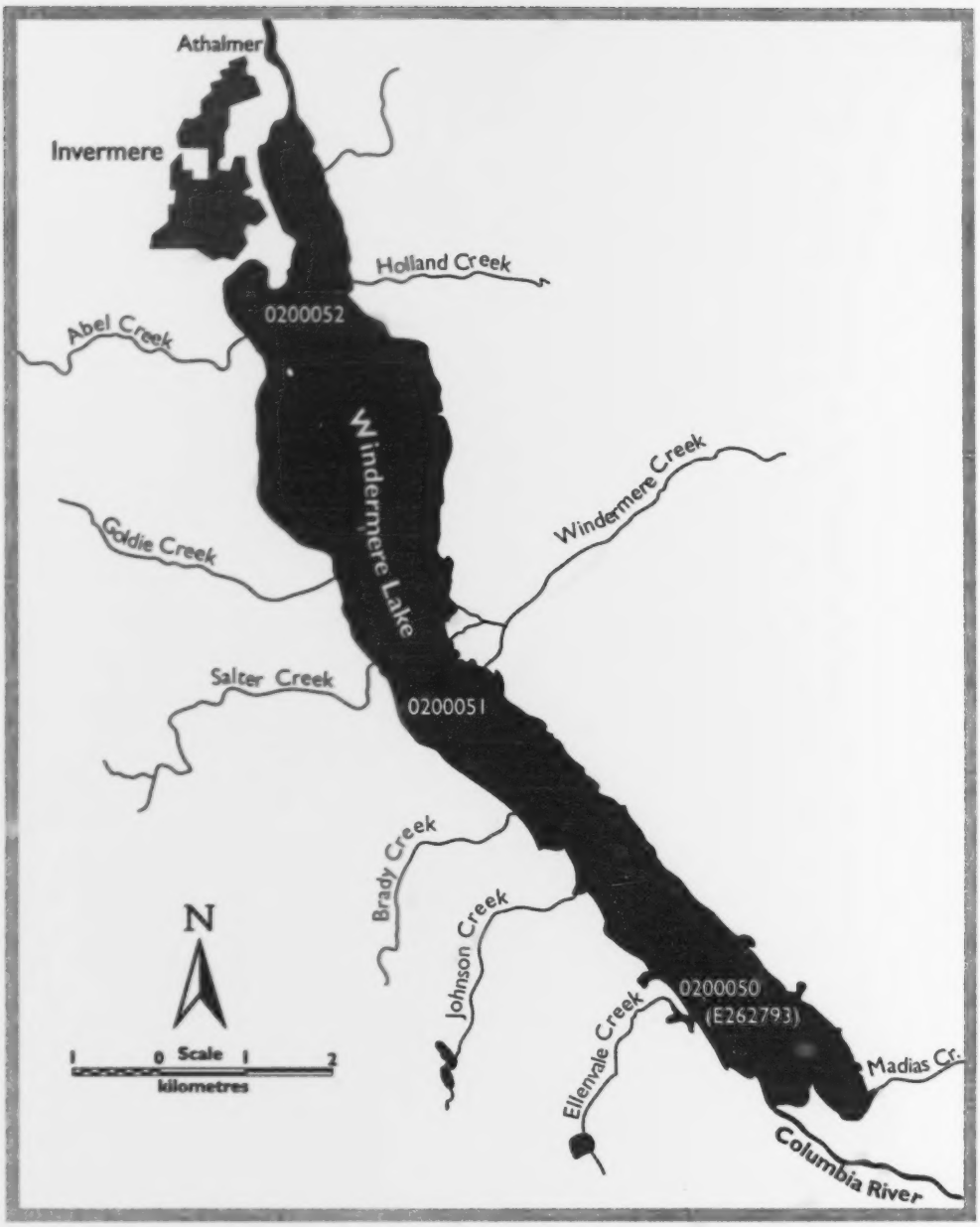

Figure 2. Locations of tributaries to Windermere Lake and water quality sampling stations.

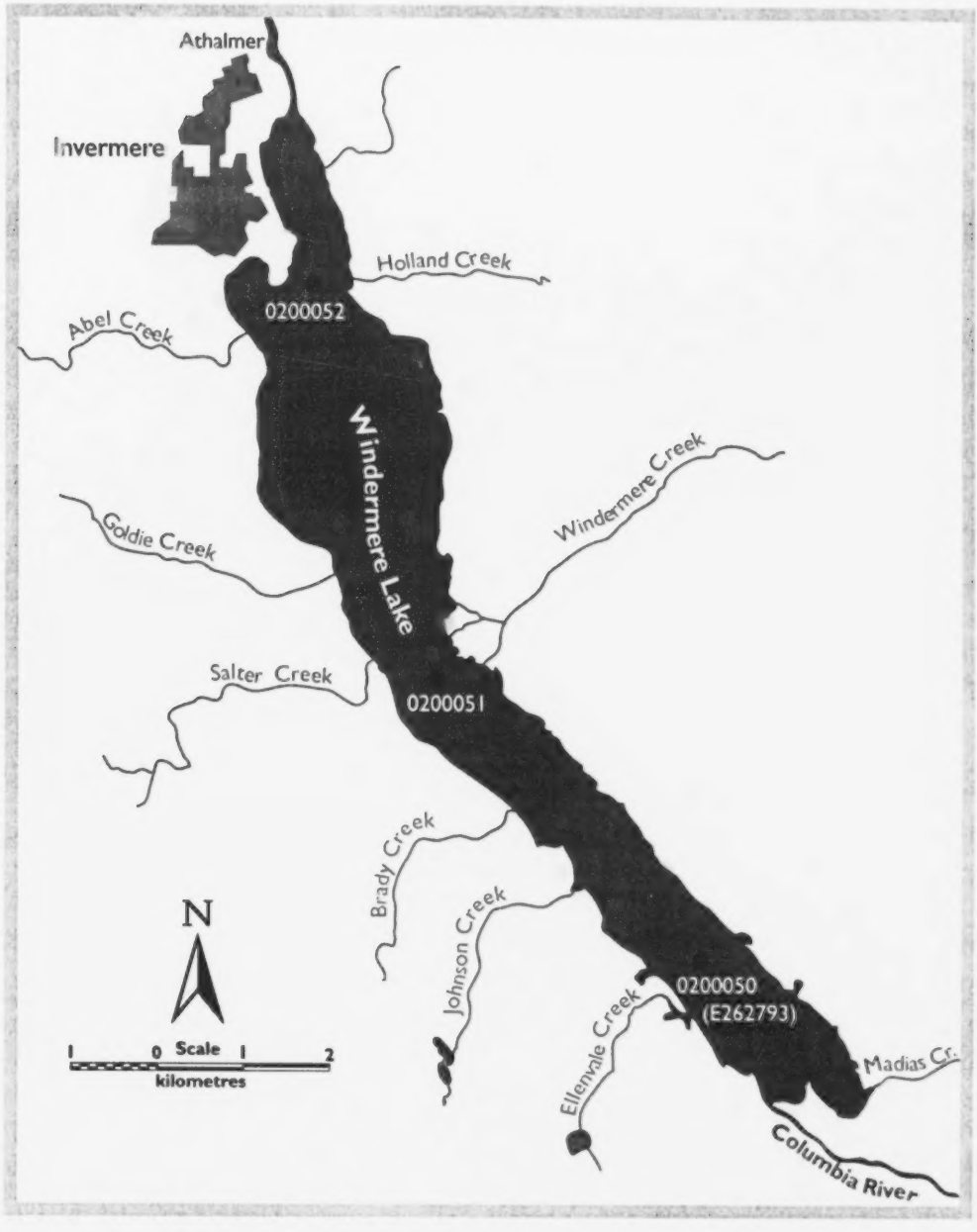

Figure 2. Locations of tributaries to Windermere Lake and water quality sampling stations.

References

McKean, C.J.P. and R.N. Nordin. 1985. Upper Columbia River, Columbia and Windermere lakes sub-basin, water quality assessment and objectives. BC Ministry of Environment. February 1985.

Urban Systems. 2001. Lake Windermere Management Strategy. *Report prepared for the District of Invermere.*